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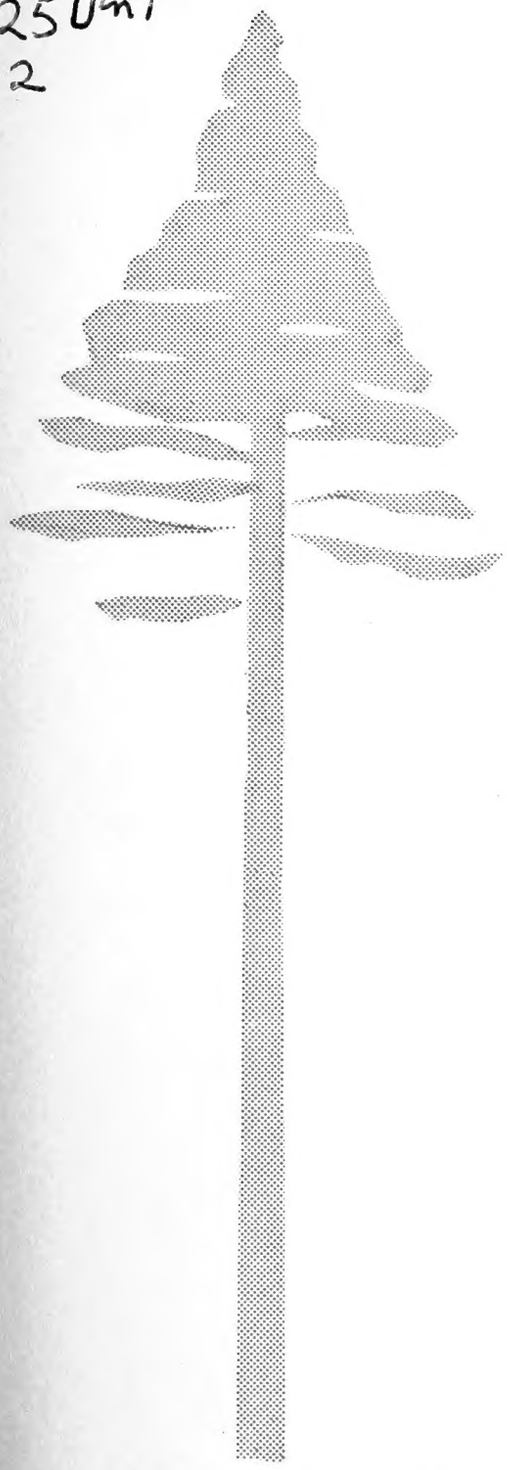
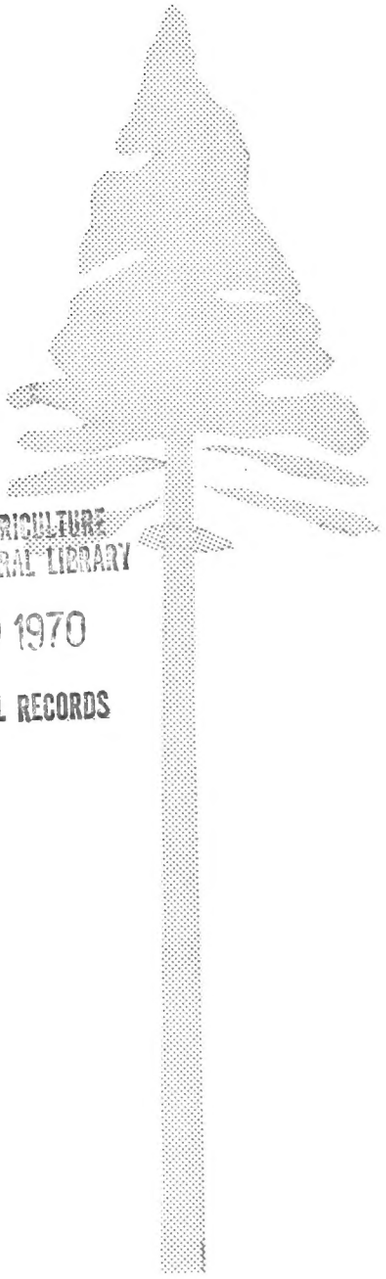
1970





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STUMPAGE PRICE RESPONSES TO CHANGES IN VOLUME OF TIMBER SOLD

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INTRODUCTION

The level of stumpage prices in relation to the quantity of National Forest timber sold is important in formulating timber sale policies.

The purpose of this report is to determine the effect on stumpage prices of changes in quantities of timber made available for harvest on the National Forests of western Washington and western Oregon.

If this relationship is known, the probable returns from alternative timber sale programs can be estimated and incorporated into the decisionmaking process. We will examine the 19-year period 1950-68.

LONG-TERM PRICE TRENDS

For perspective on the general level of stumpage prices, long-term demand, supply, and price trends will be examined first. We will then look more closely at National Forest price-quantity relationships.

Log Consumption in the Douglas-fir Region

Log consumption in the region has shown a long-term increasing trend since 1950 (table 1). Plywood and pulp production and log exports contributed to the trend (table 2). The production of plywood in Washington and Oregon was more than four times greater in 1968 than in 1950, an increase from 2.4 billion square feet in 1950 to 10.4 billion square feet in 1968. Pulp production increased almost two and one-half times during this period, from 2.4 million tons in 1951 to 5.9 million tons in 1968. During the 1950's, the volume of logs exported from the Douglas-fir region was negligible; but in 1961, log exports – mostly to Japan – became important. Since that time, the export volume has grown steadily to a level of 2.0 billion board feet in 1968. These increases in log consumption for plywood, pulp, and log exports have more than offset decreased consumption in the lumber industry, where production fell from 10.1 billion board feet in 1950 to 8.8 billion board feet in 1968, a 13.7-percent decline. Altogether, apparent log consumption for these uses rose 37.3 percent during this period, from 10.9 billion board feet, Scribner log scale, in 1950 to 15.0 billion board feet in 1968 (table 1).

Regional Timber Supply

The available timber supply from Douglas-fir region National Forests (allowable cut) increased 68.4 percent from 1950 to 1968; in 1950 annual allowable cut was 1.9 billion board feet and in 1968 the allowable cut was 3.2 billion board feet.[1] Comparable information is not available for all ownerships in the region, most notably for private lands; however, timber harvest information gives a reasonable indication of timber supplies made available over the 1950-68 time period. Total volume of timber harvested from all ownerships was 10.8 billion board feet in 1950; in 1968, total timber harvest was 13.6 billion board feet, up 25.9 percent from 1950 (table 3, fig. 1).[2]

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[1] The main reasons for this increase are better and more intensive forest inventory, inclusion of smaller diameter trees to reflect changing utilization, a shorter conversion period, expectations for increased growth rates due to a larger number of smaller trees and more intensive forest management, a shorter regeneration period, inclusion of intermediate cuts as part of the regulated allowable cut volume, and addition of lands which were formerly inaccessible for logging.

[2] Total log consumption and total timber harvest figures do not coincide because (1) timber harvest does not include log imports into the region and materials such as cull logs; (2) part of the private timber harvest volume is estimated; (3) general conversion factors do not take account of species and log size variations; and (4) minor products are excluded from the log consumption figure.

Table 1.—*Apparent log consumption in western Washington and western Oregon, by major uses, 1950-68*

Year	Sawtimber		Pulpwood[1]	Log exports[2]	Total
	Lumber	Plywood			
	Million board feet, Scribner scale				
1950	8,073	1,023	1,850[3]	—	10,946
1951	7,871	1,129	1,812	—	10,812
1952	8,281	1,163	1,850[3]	—	11,294
1953	7,786	1,392	1,850[3]	—	11,028
1954	7,402	1,467	1,850[3]	—	10,719
1955	7,710	1,908	1,850[3]	—	11,468
1956	6,977	1,955	1,878	—	10,810
1957	6,334	2,040	1,768	—	10,142
1958	6,722	2,377	1,416	—	10,515
1959	7,243	2,876	1,536	—	11,655
1960	6,437	2,838	1,616	—	10,891
1961	6,190	3,104	1,560	336	11,190
1962	6,417	3,469	1,594	311	11,791
1963	6,841	3,703	1,518	709	12,771
1964	7,092	4,213	1,495	835	13,635
1965	7,057	4,337	1,729	901	14,024
1966	6,662	4,251	1,678	1,109	13,700
1967	6,353	3,974	1,533	1,572	13,432
1968	6,963	4,488	1,609	1,974	15,034

Source: Western Wood Products Association (1966 and 1969), Northwest Pulp & Paper Association (1969), USDA Forest Service (1969).

[1] Roundwood only. Includes two mills located in eastern Washington and excludes one western Washington mill.

[2] Volume was negligible before 1961.

[3] Estimated; data not available.

Long-term changes in Douglas-fir region timber supply are primarily a result of shifts in the supply curve rather than movements along the curve.[3] For example, the changes in National Forest allowable cut came about through increased knowledge of present and future timber management and utilization rather than from direct price influence. The quantity of private timber supplied is more likely to be affected by price changes, although any such effect would be more important in the short run.

[3] A timber supply curve is a schedule showing quantities of timber that will be offered on the market at different prices during a given time period. With a change in time period, factors such as technology, management, and utilization may cause a change in the quantities offered at these prices; this represents a shift in the supply curve (see fig. 5, p. 8).

Average Stumpage Price Trend

Stumpage prices have also shown a long-term increasing trend since 1950, although they have fluctuated considerably from

Table 2.—*Lumber, plywood, and pulp production and log exports from western Washington and western Oregon, 1950-68*

Year	Lumber production	Plywood production	Pulp production[1]	Log exports[2]
	Million board feet	*Million square feet*	*Thousand tons*	*Million board feet, Scribner scale*
1950	10,091	2,378	–	–
1951	9,839	2,625	2,439	–
1952	10,351	2,705	–	–
1953	9,733	3,238	–	–
1954	9,252	3,412	–	–
1955	9,638	4,437	–	–
1956	8,721	4,546	3,173	–
1957	7,918	4,744	3,402	–
1958	8,403	5,527	3,357	–
1959	9,054	6,688	3,511	–
1960	8,046	6,600	3,712	–
1961	7,738	7,218	3,668	336
1962	8,021	8,067	3,891	311
1963	8,551	8,611	4,045	709
1964	8,865	9,798	4,358	835
1965	8,821	10,086	4,956	901
1966	8,327	9,885	5,401	1,109
1967	7,941	9,241	5,536	1,572
1968	8,704	10,438	5,903	1,974

Source: Western Wood Products Association (1966 and 1969), Northwest Pulp & Paper Association (1969), USDA Forest Service (1969).

[1]Data not available for 1950 and 1952-55 Includes two mills located in eastern Washington and excludes one western Washington mill.

[2]Volume was negligible before 1961.

year to year (fig. 2).[4] Part of this increase can be attributed to demand for additional logs; in earlier years for rising plywood production, and more recently for log export. In addition, logs have attained a greater value through more complete utilization. The entire increase in volume of pulpwood used in the region from 1950-66 has come through use of chips and residue. In 1951, 21.6 percent of total pulpwood consumption was chips and residue. In 1966, this source made up 67.9 percent of the total.

Finally, technological advances have decreased the cost of some other factors of production, leaving a larger proportion of total revenue for stumpage purchases. For example, from 1952 to 1964, worker productivity in the logging industry increased 69.6 percent, and productivity in the sawmill industry rose 49.8 percent (*11*).[5] Over

[4]Stumpage prices in this report are constant prices determined by dividing the current price in each year by the wholesale price index for all commodities (1957-59 = 100) for that year.

[5]Italic numbers in parentheses refer to Literature Cited, p. 20.

Table 3.—*Public and private timber harvest in western Washington and western Oregon, 1950-68*

Year	All ownerships	Total private	Total public	USDA Forest Service
	Million board feet, Scribner scale			
1950	10,759	7,929	2,830	1,336
1951	11,540	8,699	2,841	1,429
1952	12,248	9,367	2,881	1,553
1953	11,033	7,970	3,063	1,778
1954	10,753	7,520	3,233	1,898
1955	12,096	8,601	3,495	1,903
1956	11,981	8,546	3,435	1,939
1957	9,495	6,426	3,069	1,744
1958	9,319	5,861	3,458	2,248
1959	11,186	6,555	4,631	3,176
1960	10,818	6,938	3,880	2,518
1961	9,659	5,661	3,998	2,544
1962	11,192	6,202	4,990	3,318
1963	11,604	5,942	5,662	3,452
1964	12,898	6,674	6,224	3,641
1965	13,012	6,785	6,227	3,887
1966	12,164	6,708	5,456	3,324
1967	11,489	6,424	5,065	3,198
1968	13,590	7,302	6,288	3,778

Source: USDA Forest Service (1951-69).

the same period, hourly wages in the logging industry rose only 26.6 percent and sawmill industry hourly wages were up only 38.6 percent (*12, 13, 14*).

Stumpage Price Expectations

Over a long period of time, stumpage prices are subject to different influences than affect them in the short term. In this section, prices will be examined to determine their expected future level in light of longer term influences.

Stumpage prices should show a continued upward trend in relation to the wholesale price index, with the greatest increase occurring within the next two decades. Projections for Japanese log requirements indicate an increasing need for imports until about 1985, after which time domestically grown timber will be able to support an increasing percentage of total wood needs in Japan (*2, 6*). Log exports are unique to the Douglas-fir region because of its location, and any increase in export demand should cause an upward pressure on stumpage price.

The recent restriction on log exports from Federal lands in Washington and Oregon may dampen the increase in log export volume, but lack of a complete export embargo should lessen the effect of this restriction. In addition, if efforts by the wood products industry to increase finished product exports are successful, the demand for stumpage will not decline.

Domestic demand for wood products is also projected to increase. There are a number of factors, however, which should

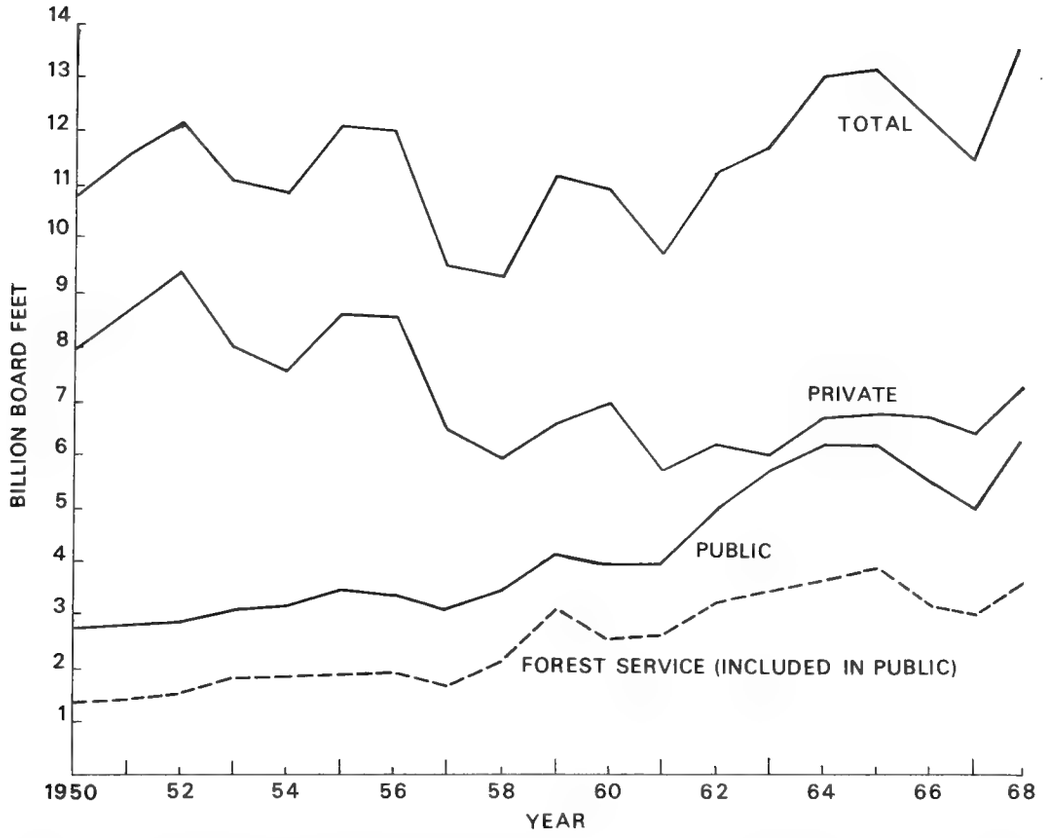

Figure 1.–Public and private timber harvest in western Washington and western Oregon, 1950-68.

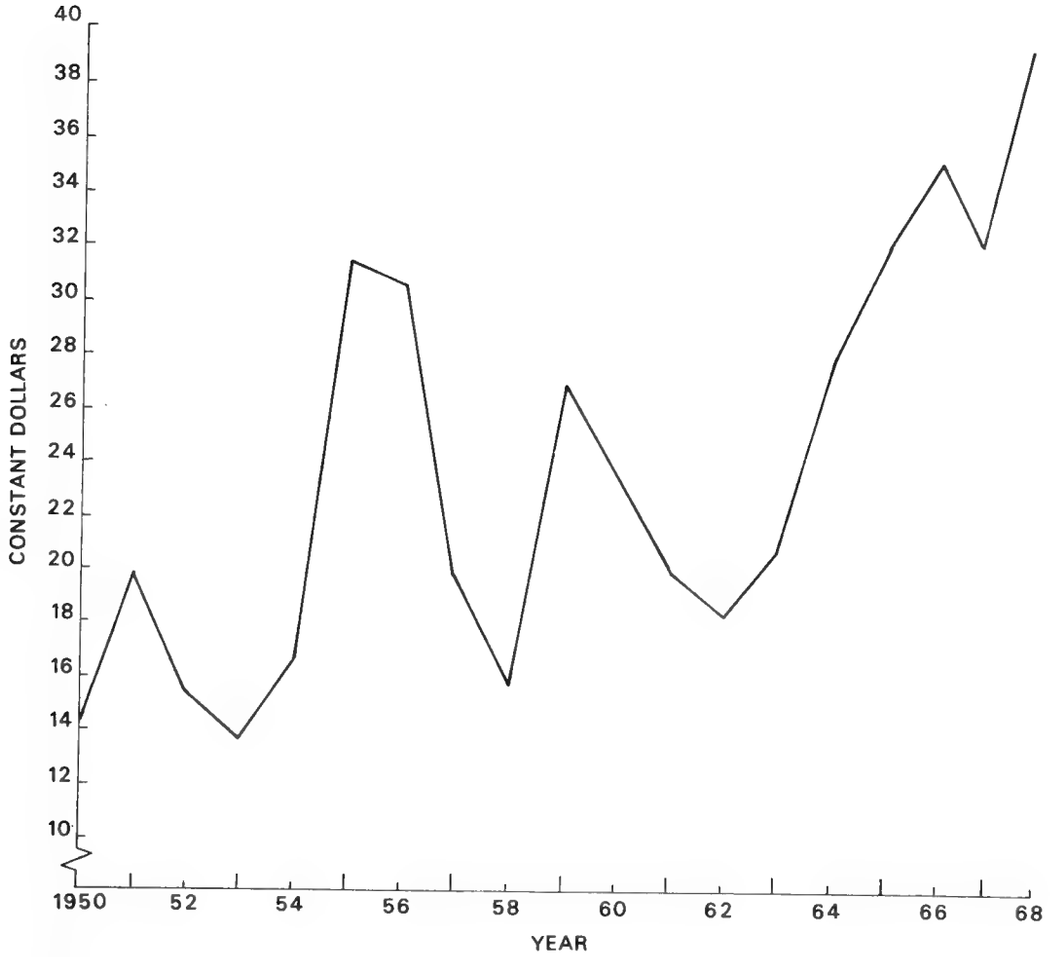

Figure 2.–Average annual stumpage prices for all species, western Washington and western Oregon National Forests, 1950-68.

dampen the price effect of this increase in the Douglas-fir region. First, other regions in the United States are currently gaining in importance in the production of some major forest products, and to some extent this gain is at the expense of the Douglas-fir region. The most notable example of this transition in area of production is in the plywood industry. In 1963, no softwood plywood was produced in the Southern States; in 1968, there were 34 plywood plants in the South which accounted for almost 16 percent of total U.S. plywood production. In 1966, plywood production in Washington and Oregon fell for the first time since 1960. This decline continued in 1967; however, 1968 production rose to a level slightly above that in 1965.

Second, other regions in the United States, principally the Rocky Mountain region, contain some areas where the allowable cut is not being completely used.[6] An increase in domestic requirements for forest products, with its accompanying upward pressure on price, should make increased cutting in these areas economically feasible.

A comparison of available volumes of timber and costs of production in each area would be necessary to determine from where additional supplies might come. Those areas which have timber just beyond the margin of profitable production would be the first to enter the market.

Third, competition from Canada, particularly British Columbia, will continue to be important. At present, British Columbia supplies about 79 percent of our Atlantic coast cargo market. Any upward pressure on price should make this market even more attractive to the Canadians. It appears that additional supplies may become available from British Columbia. From 1963 to 1968, British Columbia's allowable cut increased by 16 percent. In addition, both public and private foresters in British Columbia estimate that through more intensive management and better utilization, the harvest level of 1968, which was 1.7 billion cubic feet, could be substantially increased.

Finally, traditional wood products should continue to receive competitive pressure from nonwood substitutes.

Factors affecting demand, such as new technology, population, and foreign demand, are less predictable for long time periods. In addition, during the 1950-67 period, lumber prices have shown a relatively level long-term trend, and plywood prices have been declining despite major technological advances in wood use and substantial population gains (fig. 3). The sharp increase in prices in 1968 demonstrates the effect of a large increase in demand for wood products over a short period of time. This increase should be dampened somewhat as the factors mentioned come into play. Without long-term increasing final-product prices, stumpage price increases are possible only through better utilization, increased plant efficiency, or development of new products.

SHORTRUN PRICE CHANGES

In the short run, economic theory suggests that prices for stumpage will rise when the amount of timber offered for sale decreases and fall when timber offerings increase. In the stumpage market, the demand curve is traditionally thought to be very inelastic (see fig. 4).

There have been few studies of the characteristics of demand for stumpage *per se*, although several studies have been made in attempts to define the price elasticity of demand for timber and wood products. These studies have resulted in little success in specifying demand elasticities (*7*).[7]

[6] The National Forests in Regions 2 and 4, which include Nevada, Utah, Colorado, Nebraska, South Dakota, Wyoming, and southern Idaho, sold an average of 70 percent of their allowable cut over the period 1962-67.

[7] Holland, Irving. Some factors affecting the consumption of lumber in the United States with emphasis on demand. 1955. (Unpublished doctoral dissertation on file at Univ. Calif., Berkeley.)

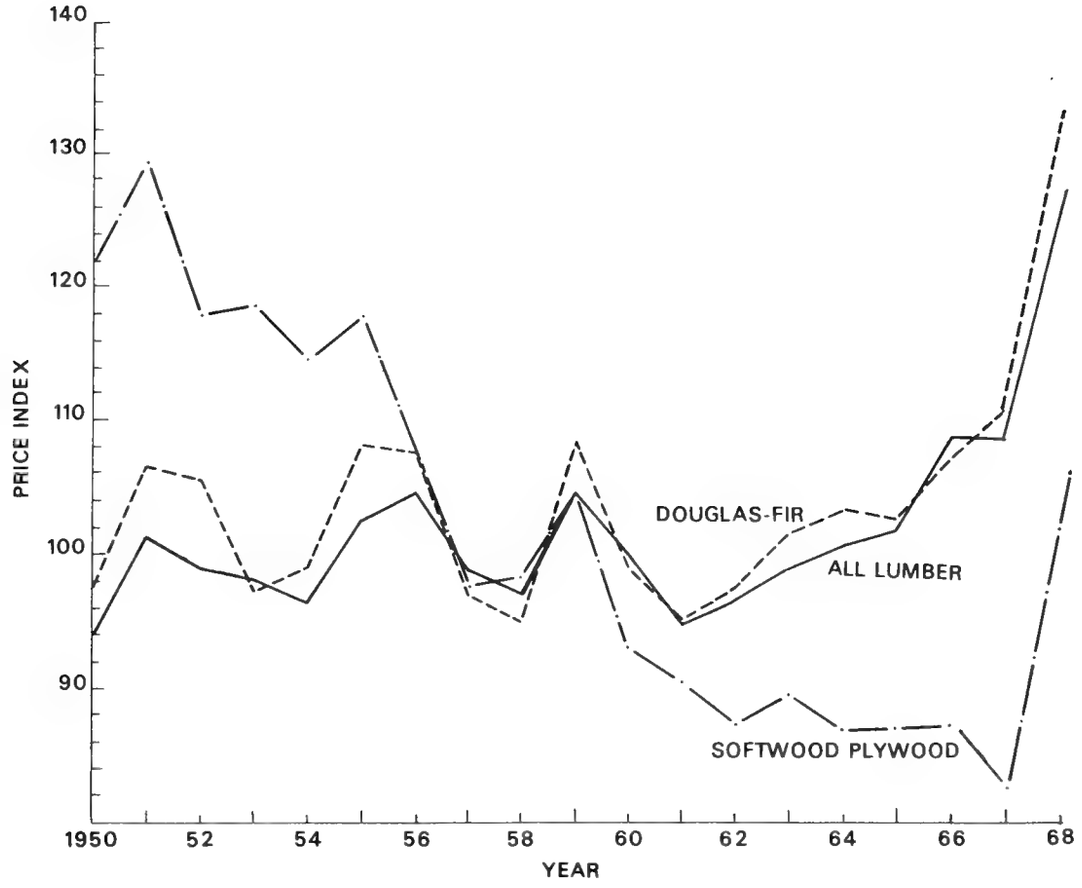

Figure 3.–Wholesale price indexes of lumber and softwood plywood, 1950-68 (1957-59 = 100). Source: U.S. Department of Labor, Bureau of Labor Statistics.

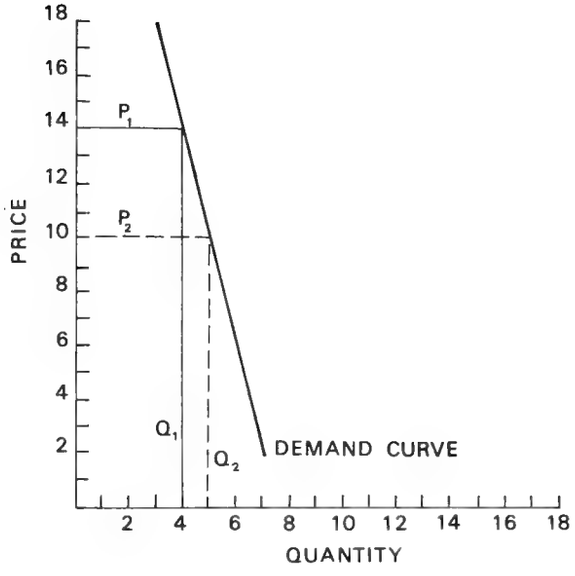

Figure 4.–An inelastic demand curve; a given percentage change of stumpage volume supplied (from Q_1 to Q_2) will be associated with a larger percentage change in stumpage price (from P_1 to P_2).

Nature of the Shortrun Regional Stumpage Demand Curve

The difficulty of specifying demand elasticities for wood products indicates that a universal statement on elasticity cannot be made. Instead, the variations in results of past studies suggest that each situation, even when similar products are considered, is unique and must be examined separately in light of its particular market characteristics.

In the Douglas-fir region, there is evidence to suggest that, except for extreme changes in stumpage availability, the demand curve for National Forest timber is highly elastic, taking the form shown in figure 5. Because of this, changes in the quantity of timber offered for sale under various harvest alternatives will have no appreciable effect on stumpage prices. This hypothesis is based on the following propositions.

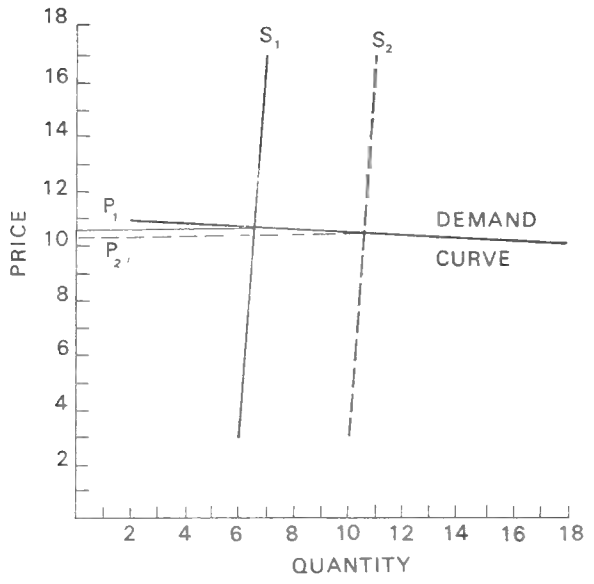

Figure 5.—An elastic demand curve; a shift from supply curve S_1 to supply curve S_2 will have little effect on stumpage prices.

Substitution.—Increased likelihood of substitution adds to the elasticity of demand for a product. As pointed out by Mead (*8*, p. 33), the greater the suitability and availability of substitutes, the greater the price elasticity of demand for a product. Since the demand for stumpage in the Douglas-fir region depends on the demand for finished products, we are interested in the availability of substitutes in both the stumpage and the final product market.

In the stumpage market, changes in the volume of logs sold on National Forest lands may bring about a response from private timberland owners. During the 1950-68 period, log production on private lands declined 7.9 percent from 7,929 million board feet to 7,302 million board feet. During the same period, timber harvest on National Forest lands more than doubled, from 1,336 million board feet in 1950 to 3,778 million board feet in 1968. The long-term decline on private lands has been attributed primarily to decreased private timber availability, rather than a response to increased public timber sales. However, during this period, fluctuations in private harvest were somewhat larger than were public fluctuations. Specifically, in periods when prices were high, private harvest was high and when prices were low, private harvest volume was low. It therefore appears that timber harvest on private lands is responsive to market conditions and that, if actions by public land managers increase or decrease available timber supplies and result in changed market conditions, these changes will be offset somewhat by private landowners' actions.

Changes in volume of Douglas-fir region National Forest timber sales may affect production in other regions. For example, areas in the Rocky Mountain region are not currently selling their entire allowable cut because the existing price-cost relationships make this material economically unavailable. Changes in log availability in the Douglas-fir region could increase or decrease the volume of timber cut in this area, thereby dampening any price change that might otherwise occur.

The effect of substitution is not limited to the stumpage market. In the consumer market, wood products and products made from other raw materials have frequently been interchanged, especially in the construction industry. A traditional concern in the forest products industry has been loss of markets to other materials. What is not usually considered, however, is the possibility that wood will recapture lost markets or move into new markets when the supply of timber is increased. This interchange between products should increase the demand elasticity in the consumer market and in the stumpage market.

Time.—The time period under consideration also affects demand elasticity. Generally, as the time period grows longer, more adjustments to a change in quantity supplied can be made and the effect of that change will be smaller. In this study, we are concerned with the effect on stumpage prices over a 1- or 2-year period following a change in annual timber sale volume on National Forests.

Obviously, time is important in the examination of substitution effects. An initial (large) change in volume of timber sold could have an immediate effect on regional prices. However, reactions to such changes appear to be rapid in the forest products industry (for example, private timber harvest fluctuated on a year-by-year basis, following general market conditions rather closely), and any price effect should be at least dampened somewhat by substitution effects.

In addition, time is important in evaluating the characteristics of the industry and stumpage market in the Douglas-fir region.

Industry and market characteristics.—Economic theory suggests that except under conditions of monopsony (a single buyer) or perfectly competitive sellers, the demand curve which an individual seller faces slopes downward to the right. Under this condition, a shift in either the demand or supply curve without a corresponding shift in the other will bring about a change in the equilibrium price.

In practice, only one situation exists where a shift in supply has no effect on price; this will happen when the supplier faces a perfectly elastic demand curve. Generally, when there is a large number of sellers, none of whom sell enough to influence price through individual supply action, the demand curve for each firm is perfectly elastic.

Mead (*8*, pp. 97-134) found that the market for lumber, which is national in scope, is unconcentrated, that barriers to entry into the lumber-producing business are relatively low, that products sold on the market are difficult to differentiate, and that lumber prices are market determined. This market condition is a close approximation of conditions under which perfect competition is found. We would therefore expect the demand curve facing individual firms in the lumber market to be very elastic (even though the total national demand curve may be much less elastic).

The same firms that sell lumber on the national market are the buyers of Federal timber on local markets. However, in the timber market, the number of firms competing for an individual sale is much smaller. Mead characterizes the buying side of this market as oligopsonistic; that is, few firms compete for timber sales in each timbershed.

Given this type of market structure, we would expect the demand curve facing timber sellers to be quite inelastic. However, several characteristics of the buying side of the stumpage market should reduce or negate any price effect which a change in supply might ordinarily have.

First, ease of entry into the buying side of the market means that firms must recognize potential entrants as well as existing firms when bidding for stumpage sales. Although stumpage prices have been found to be higher in areas where actual bidder numbers are high and lower where the number of actual bidders is low (*9*), we would expect the price differences to be even greater if the threat of future entry did not exist. In other words, the average stumpage price in areas where there are few

buyers is nearer to the price in more competitive areas than it would be if entry was difficult.

In addition, actual entry of new firms has a "self-correcting" effect on stumpage price changes resulting from changes in the quantity of supply. A hypothetical example of this effect is shown in figure 6. Assume that DD and SS represent the existing demand and supply curves for stumpage and P_1 represents the existing price. If an increase in volume of stumpage sold – a supply curve shift from SS to S'S' – causes a decline in stumpage price from P_1 to P_2 with no change in final product price, entry into the market should be induced. This would increase demand – a demand curve shift from DD to D'D' – forcing the stumpage price upward from P_2 to P_1. Although the long-term trend in number of mills has been downward during the 1950-66 period, the decline has slowed, or even reversed, during the periods of high product prices (*8*, pp. 118-119). The result has been a dampening of price fluctuations much the same as that which we would expect if supply changes induced an initial stumpage price change.

Second, the ability of the forest products industry to operate at less than capacity enables some adjustment to changes in timber supply and thereby reduces stumpage price changes. Fedkiw (*3*) found that the unused log input capacity of plywood and sawmills varied from 4.6 to 31.8 percent of total capacity over the period 1950-60 (capacity was defined as daily capacity listed by firms in the industry directory and includes one or more shifts as reported by each mill). Periods of high unused capacity during the 10-year span corresponded to periods of low stumpage prices and periods of low unused capacity coincided with those of high stumpage prices. In addition, annual fluctuations in total regional mill capacity, total regional log production, and stumpage prices were directly related in terms of highs and lows. Here it appears that demand rather than supply exerted the primary influence on stumpage prices. In addition, mills in the region can vary the degree to which their facilities are used according to market circumstances.

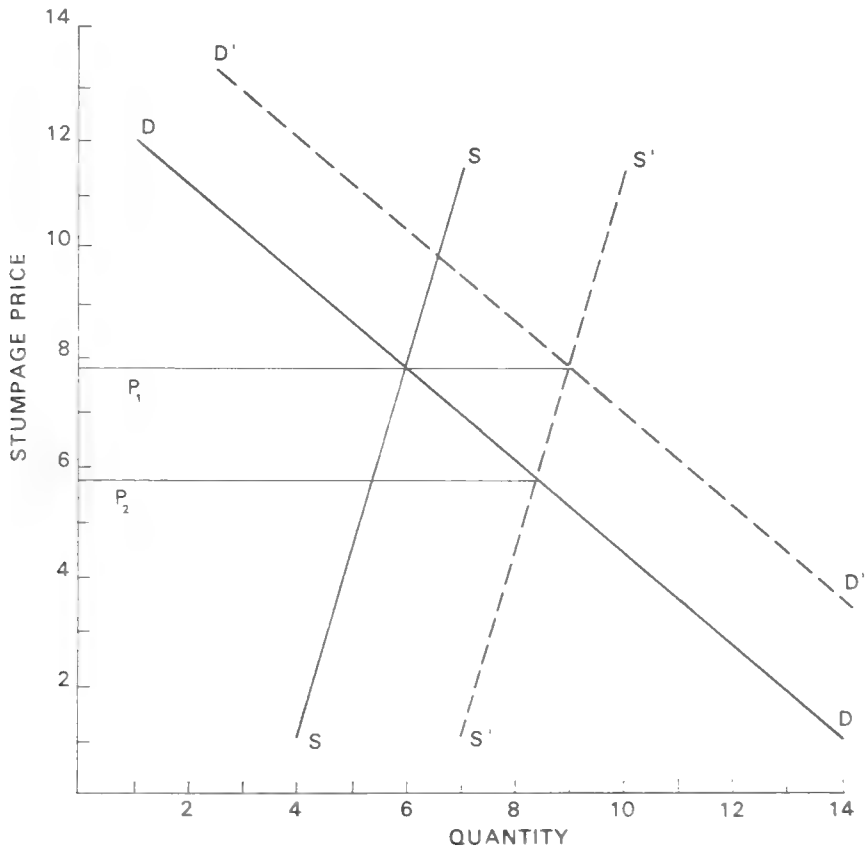

Figure 6.–The effect on price by entry of new firms as a result of a supply change.

This industry flexibility suggests, as we have hypothesized, that although overall stumpage demand may take the traditional downward sloping to the right form, within certain limits it is relatively elastic. Part of the reason for this may be reflected by the shape of the production function and stumpage demand curve for each forest-product firm.[8] Willingness of firms to operate at varying levels of output indicates that there may be little difference in productive efficiency at these different levels. In other words, the firm's production function has a range over which increased output per unit of additional input remains the same. Since an individual firm receives the same price for its product regardless of level of output, its total revenue curve would also increase at a constant rate per additional unit of input over this range. The demand curve for stumpage would take a form similar to that shown in figure 7. This curve shows the addition to total revenue from adding additional units of variable input. Over the range where increased output per unit of additional input is constant, the stumpage demand curve is horizontal. This horizontal (or elastic) portion of the demand curve may be relatively small for an individual firm; however, the cumulative effect of lumping all firms buying stumpage in a market area (fig. 8) could make productive flexibility an important factor in dampening price responses to changes in timber supply.

Public timber sale contracts are usually made for a period of 3 or more years. Because of this, timber buyers are able to hold a stumpage inventory of timber purchased but uncut. This inventory of uncut volume under contract in Washington and Oregon has been about twice the public timberland allowable cut over the past few years (*1, 5*). An increase in the volume of timber sold by public agencies could also be held as stumpage inventory while firms in the market are adjusting to the change. This ability to "store" timber on the stump would also tend to increase the elasticity of demand for stumpage.

Finally, the demand for stumpage is a derived demand; that is, it is dependent on the demand for products made from the stumpage. We would expect, as has been shown above, that fluctuations in prices for final products would produce similar price fluctuations in the stumpage market, and that high elasticity in final-product demand should produce high elasticity in the demand for stumpage. Since the demand for final products facing firms in individual timbersheds is very elastic, the demand for stumpage should also be elastic. One characteristic of derived demand is that its elasticity is usually less than the elasticity of the demand schedule from which it is derived. If, however, the deriving schedule has an infinite or nearly infinite elasticity, then the derived schedule should also be highly elastic.

Utilization.—Changes in the available volume of timber could also contribute to changes in degree of timber utilization. For example, a decline in physical timber supply could bring about use of material that might otherwise be left as logging residue. In addition, adoption of new technology in manufacturing (e.g., narrower saw kerf, thinner veneer) could enable output from a given log input to increase. Increased stumpage availability could have the opposite effect; that is, more material left in the woods or a slowdown in the rate of technological change.

Examples of this effect on utilization have been evident since the initiation of log exports. In recent years, a good deal of interest has been expressed in the chipping of currently unused materials. In addition, the operation of "chip-and-saw" mills, which can readily use small material, has been increasing.

Administrative regulation of logging or manufacturing practices could serve to offset or to emphasize utilization effects on prices. For example, requirements that loggers must remove all material to a given board-foot minimum would not allow substitution of additional stumpage sales

[8] A production function is a relationship describing the level of total production associated with each level of variable input such as the volume of lumber per 8-hour shift produced in a sawmill as related to number of workers employed.

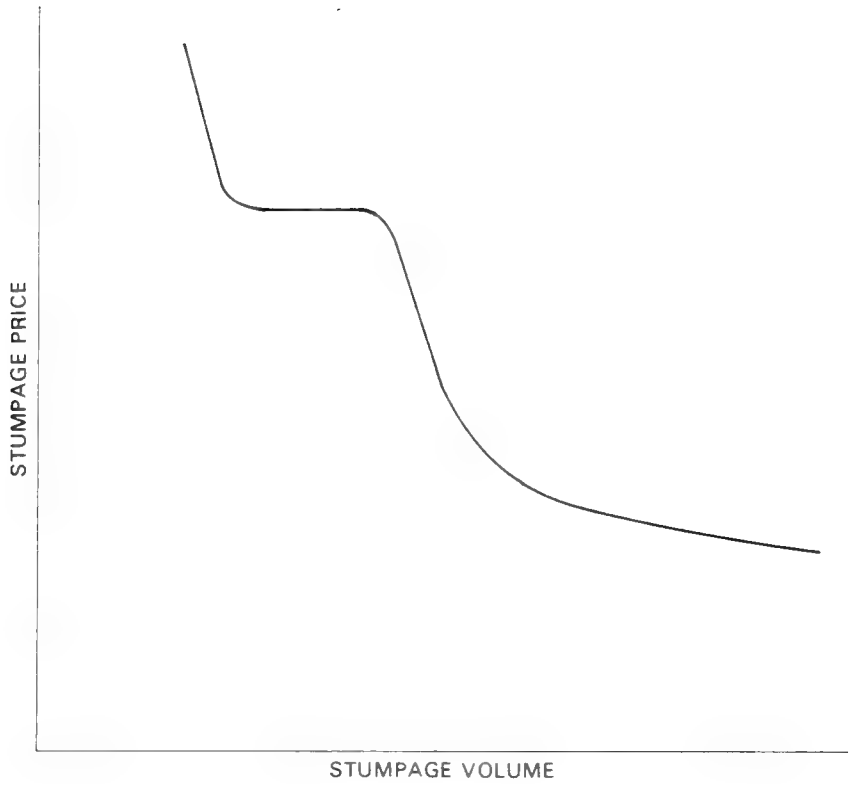

Figure 7.—A stumpage demand curve based on a production function with constant output per unit of additional input over part of its length and no variation in final product prices.

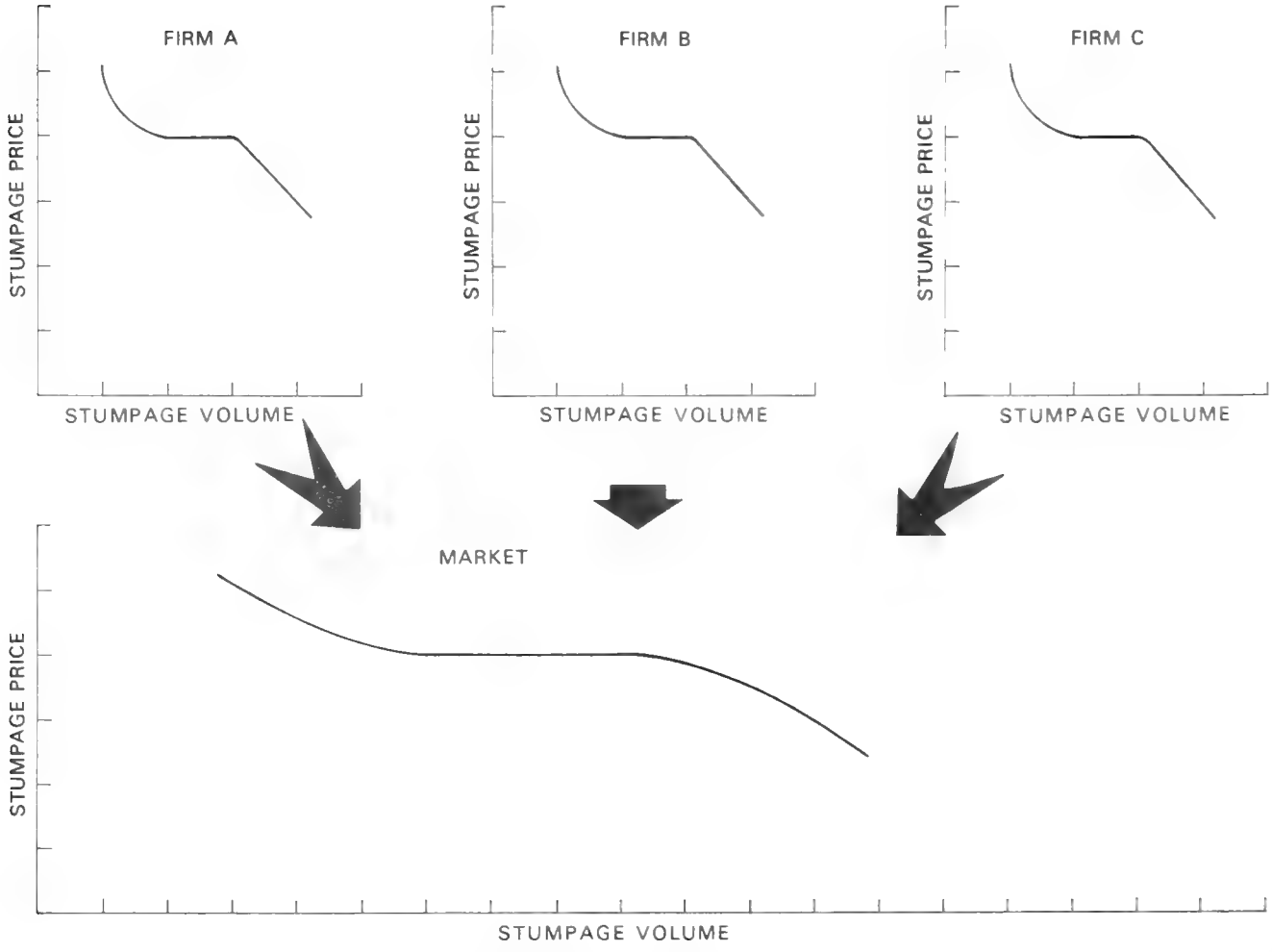

Figure 8.—An example of individual firm and market demand curves for stumpage.

for material that is more costly to remove on existing sales. Restrictions on the use of waste burners at manufacturing sites or slash burning in the woods would require alternative methods of residue disposal; some of these alternatives, such as chip manufacturing, would represent increased log utilization.

Relation of Stumpage Price Fluctuations to General Economic Fluctuations

To test our hypothesis, we will examine past shortrun stumpage price fluctuations with the accompanying changes in quantity demanded and supplied.

Figure 2 shows the all-species average annual Douglas-fir region stumpage prices from 1950-68. Although our long-term analysis showed an upward trend, there has been a good deal of fluctuation on a year-to-year basis. These fluctuations appear to be closely related to fluctuations in the general economy.

Figures 9, 10, 11, and 12 show four indicators of economic activity; U.S. gross national product, an index of common stock prices, rate of unemployment in the United States, and housing starts for the period 1950-68. The average stumpage price was at a low in 1954, 1958, and 1962. All four economic indicators declined or showed an appreciable slowing during or immediately before these years.

There are three primary reasons why the low points in these curves would not be expected to coincide. First, three of the statistics – housing starts, stock prices, and the unemployment rate – are leading indicators and would be expected to bottom slightly before the trough of a recessionary period. Second, the annual data do not allow precise pinpointing of the low point in aggregate economic activity. For example, the first recessionary period began in mid-1953 and ended in mid-1954, and the second lasted from mid-1957 to early 1958. The magnitude of the decline and recovery would therefore be important in determining the year in which the low value on the long-term annual trend fell. Finally, we would not expect any one variable to exactly fit aggregate fluctuations.

We will hypothesize that fluctuations in the general price level – characterized here by prices for wood products – have a positive influence on prices bid for National Forest stumpage. In other words, if prices paid for manufactured wood products are high, we would expect stumpage prices to be high; and if final-product prices are low, we would expect low stumpage prices.

It is difficult to directly relate prices bid for stumpage to final-product prices because of the wide and ever-changing variety of products and because the proportion of different species and grades sold each year varies.[9] However, the appraisal procedure used in setting a lower limit on stumpage prices is designed to take account of these variations. Although stumpage may not be used for the purpose for which it is appraised, the appraisal should represent a general pattern of final-product price changes.

In testing our hypothesis, we would expect the same relationship between bid and appraised prices as we would between bid and final-product prices; that is, bid prices should be high when appraised prices are high and low when appraisals are low.

In testing for correlation between bid and appraised prices over the period 1951-68, we obtain a coefficient of correlation of 0.87 and a coefficient of determination of 0.75, which means that 75 percent of the variation in bid prices may be explained by our measure of final-product price level, the appraised price. It therefore appears that final-product prices have a strong influence on the prices bid for stumpage.

[9] A comparison of figures 2 and 3 shows that shortrun peaks and troughs in the longrun stumpage and final-product price trends are roughly coincidental.

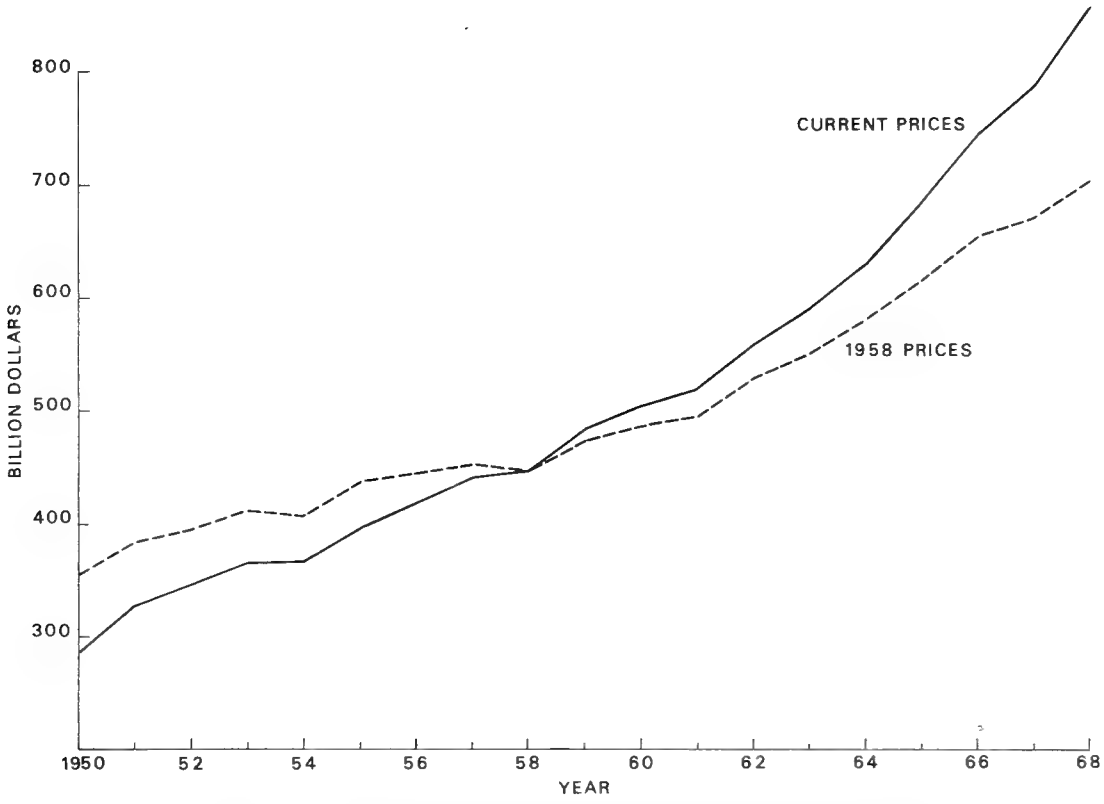

Figure 9.—United States gross national product, 1950-68.

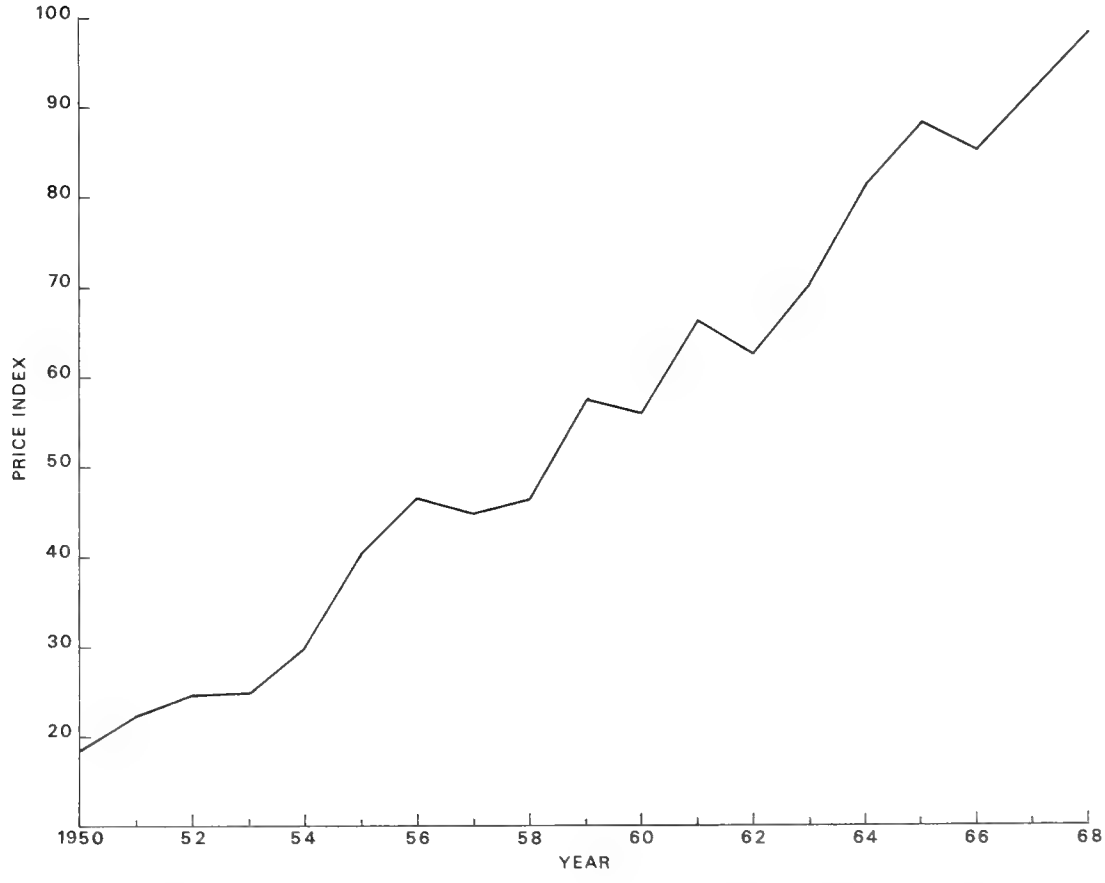

Figure 10.—Index of common stock prices, 1950-68 (1941-43 = 10).

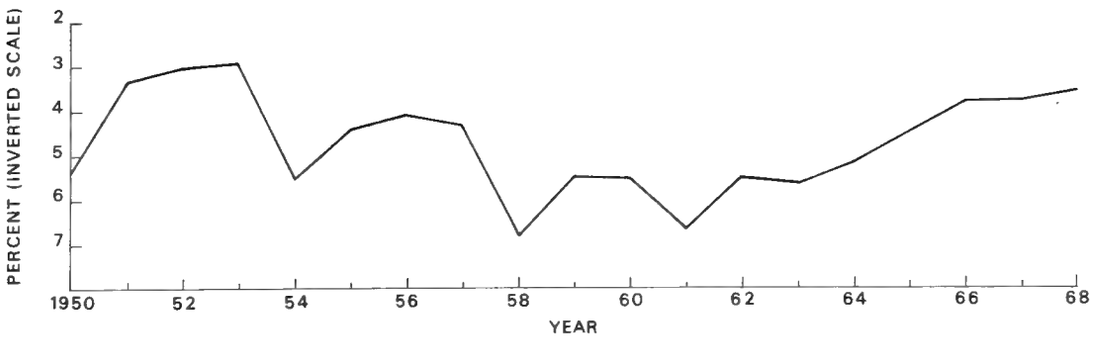

Figure 11.–U.S. unemployment rate, all workers, 1950-68.

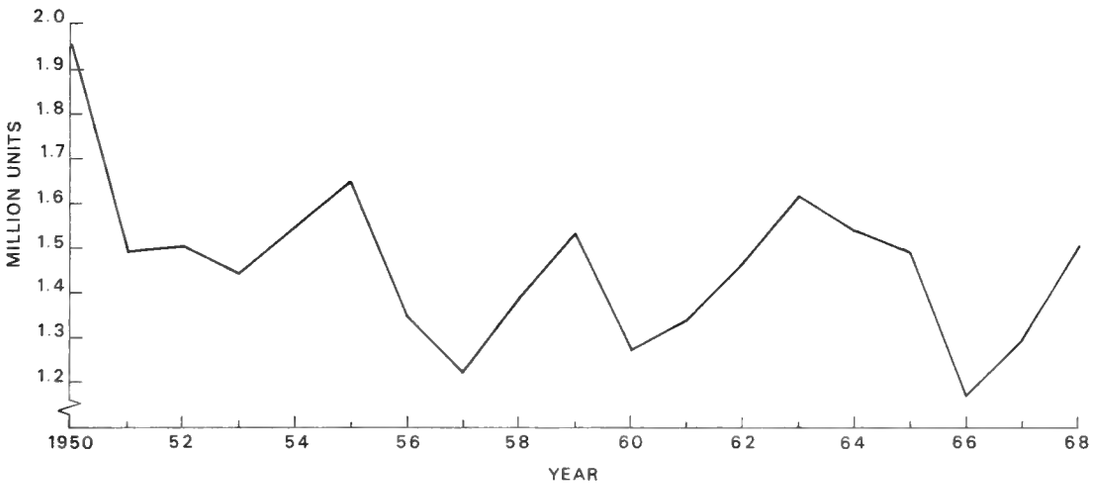

Figure 12.–Private and public, farm and nonfarm housing starts, 1950-68.

Further evidence of the effect of product prices can be seen in a comparison of the periods before and during the rapid rise in log export volume (table 4). Over the 13-year period 1951-63 when log exports were negligible, the ratio of bid to appraised price was 1.53:1, and bid prices exceeded appraisals by an average of $7.05 per thousand board feet. During the 5-year period 1964-68, bid prices averaged $11.58 more than appraisals and the bid-appraisal ratio was 1.84:1. Since log exports are not considered when appraisals are made, their effect should be like that observed – bid prices increasing at a much more rapid rate than appraisals.

Stumpage Price-Sale Volume Relationships

There is an imperfect year-by-year relationship between sale volume and allowable cut levels on National Forests. The allowable cut has increased steadily over the period we have been considering, the largest increase being 10.4 percent in 1957 (table 5). The only decline occurred in 1955 when allowable cut decreased 0.5 percent.

Since we are concerned with the price effects of changes in available timber supply, sale volume rather than allowable cut

Table 4.—*Volume and value of logs exported from Washington and Oregon, 1961-68*

Year	Volume	Value
	Million board feet, Scribner scale	*Dollars per thousand board feet*
1961	336	75.88
1962	311	69.65
1963	709	64.33
1964	835	67.98
1965	901	78.17
1966	1,109	82.84
1967	1,572	88.91
1968	1,974	102.37

Source: USDA Forest Service (1968).

Table 5.—*Allowable cut and volume sold on western Washington and western Oregon National Forests, 1951-68*

Year	Allowable cut		Volume sold	
	Volume	Change from previous year	Volume	Change from previous year
	Million board feet, Scribner scale	*Percent*	*Million board feet, Scribner scale*	*Percent*
1951	1,891		1,239	
1952	1,981	4.8	1,908	54.0
1953	2,020	2.0	1,368	-28.3
1954	2,187	8.3	1,860	36.0
1955	2,177	-.5	2,169	16.6
1956	2,272	4.4	2,233	3.0
1957	2,509	10.4	2,052	-8.1
1958	2,742	9.3	3,555	73.2
1959	2,783	1.5	3,140	-11.7
1960	2,815	1.1	3,085	-1.8
1961	2,822	.2	3,193	3.5
1962	2,988	5.9	3,041	-4.8
1963	2,988	—	4,306	41.6
1964	2,988	—	3,117	-27.6
1965	2,995	.2	3,191	2.4
1966	3,009	.5	3,450	8.1
1967	3,164	5.2	3,008	-12.8
1968	3,194	.9	3,545	11.8

Source: USDA Forest Service (1951-69a and b).

is the important variable. Over the period 1951-68, the volume of Forest Service timber sold in the Douglas-fir region fluctuated much more widely than allowable cut; in 6 of the 18 years, changes in sale volume exceeded 25 percent. These fluctuations appear to be responses to industry needs; for example, changes in sale volume, when compared to housing start variations, coincide with or occur 1 year after trend changes in the level of housing starts.

With the large observed fluctuations in volume sold, we would expect to find corresponding fluctuations in stumpage price in the opposite direction. Four periods in which sale volume increased substantially were from 1951 to 1952, up 54 percent; from 1953 to 1955, up 58.6 percent; from 1957 to 1958, up 73.2 percent; and from 1962 to 1963, up 41.6 percent. In two of these periods, 1951-52 and 1957-58, the quantity increase was accompanied by a stumpage price decline. In the other two periods, the increases in sale volume were accompanied by stumpage price rises. Part of this behavior can be explained by the indicators of economic activity shown in figures 9 through 12. For example, the two periods in which stumpage price declined followed substantial decreases in the level of housing starts. When fluctuations in housing starts and stumpage prices are compared, the housing movements appear to lead prices by 1 year.

On the other hand, housing starts increased during the two periods in which stumpage prices rose, and these periods followed years when housing starts were either relatively stable or increasing.

Four periods of declining sale volume were: from 1952 to 1953, down 28.3 percent; from 1958 to 1959, down 11.7 percent; from 1963 to 1964, down 27.6 percent; and from 1966 to 1967, down 12.8 percent. In the first of these, both stumpage prices and housing starts showed a decline, but in the second and third periods, decreased sale volumes were accompanied by price rises. Both of these periods followed years when housing starts increased; and in the 1963-64 period, log exports were becoming a factor in stumpage price determination. In the 1966-67 period, which followed a sharp drop in housing starts, prices declined.

If sale volume changes and changes in stumpage price are related, this relationship is even less clear on a Forest rather than a regional basis. In table 6, the number of Douglas-fir region Forests experiencing sale volume and stumpage price increases and decreases for the years 1956-68 is shown.

Table 6.—*Number of Douglas-fir region National Forests showing sale volume and average stumpage price increases and decreases, 1956-68*

Year	Volume		Price	
	Increase	Decrease	Increase	Decrease
1956	5	5	5	5
1957	3	7	1	9
1958	10	0	0	10
1959	2	8	10	0
1960	4	6	1	9
1961	5	5	3	7
1962	5	5	1	9
1963	9	1	8	2
1964	1	9	9	1
1965	5	5	9	1
1966	6	4	8	2
1967	3	7	3	7
1968	8	2	10	0

The direction of stumpage price change is much more uniform than the direction of sale volume change. In every year except 1956 in at least seven of the 10 Forests, stumpage price changes were in the same direction. Sale volume changes were not as uniform in directional movement; there was a distinct upward or downward movement in volume sold in 7 of the 13 years examined. In addition, the widespread increase in sale volume in 1963 and the decline in 1964 were a result of the October 1962 windstorm. It therefore appears that on a Forest-by-Forest basis there has been little relation between changes in volume sold and changes in average stumpage prices. This does not mean that volume sold has no effect on average stumpage price. Instead, it merely lends support to the contention that demand rather than supply factors are the dominant variables in determining shortrun stumpage prices.

Price Effect of a Net Change in National Log Supply

Physical supply changes appear to have little effect on regional stumpage prices. What would be the magnitude of a region-wide National Forest log supply change in terms of national log production, and what might be the stumpage price effect assuming no other changes take place?

Table 7 compares Douglas-fir region National Forest log production with total U.S. apparent log consumption. Although the proportion produced on the Douglas-fir region National Forests has increased over the 1950-68 period, in 1968 the region's National Forests accounted for only 4.8 percent of the total.[10]

If we assume the demand for wood products in terms of stumpage is very inelastic – for convenience we will use -0.1 in calculating the effect of a quantity change in log supply – and also assume no change in competition from other areas, competition from nonwood-based products, utilization standards, response of other landowners in the region, and the market's structure, we can calculate the price change associated with a 50-percent increase in National Forest timber sales in the Douglas-fir region. A 50-percent increase would amount to approximately 315 million cubic feet or an increase in the national total of 2.4 percent. Since the percentage change in quantity divided by the elasticity will yield the percentage change in price, this quantity increase would result in a 24-percent decrease in stumpage price.

The percentage change in price would decline rapidly as more elastic demand is assumed. For example, a demand elasticity of -0.5 (still inelastic) associated with the quantity changes given above would indicate a 4.8-percent stumpage price decrease. If an elasticity coefficient greater than -1.0 were assumed, the price change would be smaller in percentage terms than the change in quantity.

If, in addition, we relax our assumption of no other changes, factors we have discussed earlier will take effect. Since the Douglas-fir region's National Forests now provide less than 5 percent of the total roundwood for the Nation, and since changes we are considering here would probably be an even smaller percent of the total, these factors should markedly dampen the price effect of the supply changes being considered here.

[10] The U.S. log consumption figures shown are for all log uses. If only saw-log and veneer log consumption is considered – which is the use of most of the logs produced in the Douglas-fir region – the percentage of total U.S. consumption produced in the region is higher. For example, in 1968, Douglas-fir region log production was 8.1 percent of total U.S. saw-log and veneer log consumption.

Table 7.—*Log production on western Washington and western Oregon National Forests and total U.S. log consumption, 1951-68*

Year	Western Washington and western Oregon National Forest log production[1]	Total U.S. log consumption[2]	National Forest production, percent of total U.S. consumption
	Million cubic feet		
1951	238	12,055	2.0
1952	259	11,845	2.2
1953	296	11,925	2.5
1954	316	11,830	2.7
1955	317	12,230	2.6
1956	323	12,490	2.6
1957	291	11,300	2.6
1958	375	11,215	3.3
1959	529	12,160	4.4
1960	420	11,360	3.7
1961	424	11,230	3.8
1962	553	11,590	4.8
1963	575	11,970	4.8
1964	607	12,640	4.8
1965	648	12,855	5.0
1966	554	13,005	4.3
1967	533	12,480	4.3
1968	630	13,040	4.8

[1]Calculated from log production reports, Pacific Northwest Forest and Range Experiment Station, USDA Forest Service, using a factor of 6 board feet per cubic foot.

[2]From Demand and Price Situation for Forest Products, 1968-69, U.S. Department of Agriculture Misc. Pub. 1086; data for 1966, 1967, and 1968 are preliminary estimates.

CONCLUSIONS

Average stumpage prices for timber sold on Douglas-fir region National Forests have shown a longrun increasing trend. This trend should continue throughout the 1970's but begin to level off after that time. Despite the upward trend, these prices have fluctuated a good deal on a year-to-year basis.

An examination of the market for the region's stumpage indicates that shifts in wood products demand, rather than changes in the quantity of stumpage offered for sale, are the primary determinants of short-run price fluctuations. These fluctuations have closely coincided with fluctuations in general economic activity. On the other hand, variations in National Forest timber sale volume did not prove to be good indicators of stumpage price changes.

The results of this study suggest that changes in the volume of National Forest timber offered for sale – unless such changes are extreme – will have little effect on the general level of stumpage prices in the Douglas-fir region. The characteristics of the stumpage market – competitive demand conditions, industry adjustment to change, and supply response from other landowners and other areas – are such that both inter- and intra-regional adjustments should dampen a large part of the effect a supply change might otherwise have.

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Stumpage prices on Douglas-fir region National Forests have shown a long-term increasing trend which is expected to continue until the mid-1980's. In the short term, stumpage prices have fluctuated considerably. An examination of the region's stumpage market indicates that shifts in demand for wood products, rather than changes in the quantity of stumpage offered for sale, are the primary determinants of these short-term price fluctuations.

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